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✓ THE FIELD STATUS OF PARASITES OF THE EUROPEAN CORN BORER
AT THE CLOSE OF 1948

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Hibernating larvae of the European corn borer (*Pyrausta nubilalis*, (Hbn.)) were collected^{1/} in 22 States in the fall of 1948 and spring of 1949, and pupae of the overwintering generation from one State in the spring, to determine the establishment, maintenance, and dispersion of parasites introduced to aid in control of this pest. Data were obtained on 42,225 larvae and 129 pupae by the individual isolation method.

Two methods were used to delimit the localities from which borers were collected. The first method was to collect borers close to parasite-colonization sites, and in these localities from 1 to 25 collections were made. Borers were obtained by this method from 12 States at 104 localities, and they comprised 463 samples containing 15,053 specimens. The second method was to collect borers from extensive areas without regard to parasite-colonization sites. Numbered sections were outlined on State maps. Each section was either 10-miles square or a township, providing a systematic random sampling pattern. A sample of 50 borers was collected from the approximate center or, if not obtainable there, any place within the section or township. Borers were obtained by this method from 16 States, and comprised 601 samples including 27,172 specimens.

Collections Made at Colonization Points

The collections made at parasite-colonization points and in some other localities are summarized in table 1.

^{1/} All of the collections from Delaware, Kentucky, Maine, Maryland, Minnesota, Missouri, Nebraska, New Hampshire, New York, Pennsylvania, and Wisconsin, and many of those from Illinois, Indiana, Iowa, Michigan, New Jersey, Ohio, and Virginia were obtained through the cooperation of the agricultural experiment station, department of agriculture, or extension service entomologists in the respective States.

Illinois

There were 33 collections from 9 localities in Illinois. Horogenes punctorius (Roman) was not recovered from LaSalle County where it had shown initial establishment when released in 1947.

Lydella stabulans grisescens R. and D. was the only exotic species recovered in the State in 1948. It was taken in each locality except in Champaign County where none had been released, and in Peoria County where it had persisted at a low level in 1946 and 1947, following a 1944 release. L. grisescens has persisted for 3 to 5 years at all of the other localities except in Hancock County, where it was released but not recovered in 1947, but was taken in 1948. Collections were taken in the same 12 polar-coordinate sections at Bruce in LaSalle County in 1947 and 1948. L. grisescens parasitized about the same percentage of the total borers in both years, but in 1948 it was taken in only 10 of the 12 collections, whereas, it occurred in every one in 1947.

Pyraustomyia penitalis Coq. was the only native species found among the 1948 collections, and it occurred only in Hancock County.

Indiana

In Indiana 126 samples were taken in 18 parasite-colonization localities. Four exotic species of parasites were recovered in 1948. Eulophus viridulus Thoms., was taken in three counties - Jasper, Kosciusko, and Vermillion. The only releases of this species were made before 1940 in the northeastern part of the State. Horogenes punctorius was recovered from one of three Steuben County collections in 1948. It was released and recovered in York Township in this County in each of three years, 1930, 1931, and 1932, but was not taken from collections made there in 1933, 1935, 1938, and 1944 when it was not released. The sample which produced it in 1948 consisted of 92 borers, 20 of which were parasitized. They were collected from Clear Lake Township which adjoins York. The only other recovery of H. punctorius in the State was in Tipton County, following releases made in 1943 and 1944, but it has not been taken in annual collections made there since 1944.

Lydella stabulans grisescens was not released in Indiana in 1948. It is noteworthy that where a release was made in Steuben County in 1929, and recoveries made in 1929, 1930, 1933, and 1938 but not in 1931, 1932, 1935, and 1944 collections, it was again recovered in 1948. After initial establishment of L. grisescens was obtained in any other locality, it was always recovered wherever a collection was taken in a later year, and a later collection was taken in all but one - Benton County, where initial establishment was shown in 1947. This species was never recovered where it was released in Fountain and Marshall Counties, but it was never released in the Hendricks or Porter County localities where it was recovered in 1948, probably having spread into them from other localities. Initial establishment was shown in Jasper County in 1944 when L. grisescens was released there, and in 1947 and 1948 parasitization exceeded 12 percent there among extensive collections. In the last year it occurred in 14 of the 19 samples taken. The first release

in Tipton County was made in 1943, and establishment was shown when the first collection was taken there in 1944. Parasitization amounted to 30 percent among extensive collections in 1945, 1946, and 1947, dropped to 27 percent in 1948, but then it was taken in every one of the 25 collections.

Macrocentrus gifuensis Ashm., was recovered in Indiana in 1948 - the first record of establishment in the State - when one borer from Clear Lake Township, Steuben County, produced a mass of cocoons of this species. Extensive releases were made in that vicinity in 1948. Releases have been made in 34 localities in the State, most of them since 1944, but collections have not been obtained from all of them.

Pyraustomyia penitalis, taken in three northern Indiana counties, was the only native species found in the 1948 collections.

Iowa

There were 88 collections taken at 20 Iowa parasite-colonization localities, including 2,751 borers among the fall collections. Fourteen additional collections were taken in the Sweetland, Muscatine County study locality in the spring of 1949, containing 422 hibernating larval forms, including 129 pupae. Thus the total observed was 102 collections and 3,173 borers.

Recoveries of Eulophus viridulus in Iowa in 1948 are the first of this species in the State. This species was never released in Jackson or Poweshiek Counties, but releases were made in eastern and east-central Iowa annually from 1945 through 1947. It was released at the Plymouth County locality in 1948.

Recovery records of Lydella stabulans grisescens for the last 5 years, 1944 through 1948, show that it has survived wherever a collection was taken in any year after it showed initial establishment, except in Linn County in 1946, when it was not found after initial establishment was obtained in 1944, but it was taken there in 1948. Collections have not been made to determine if L. grisescens survived where initial establishment was shown in 1945 in Black Hawk, Buchanan, Jasper, and Washington Counties, nor in Guthrie County where it was released and recovered in 1947. Initial establishment was shown in Fremont and Plymouth Counties following 1948 releases.

Macrocentrus gifuensis, in 1948, showed survival for 1 year in Hancock County where it was released in 1947, but it was not taken at Monmouth, Jackson County, where it showed survival in 1947 from releases in 1945 and 1946. No later collections have been taken in Black Hawk and Mitchell Counties where it was released and recovered in 1946 and 1947, respectively. M. gifuensis was released and recovered at Sweetland, Muscatine County, in 1944, 1946, and 1948, but was not recovered from extensive collections in 1945 and 1947. The 1949 spring collections showed that it survived the winter in this locality.

Two native species were reared from the corn borers in these collections, Pyraustomyia penitalis from larvae taken in Linn and Poweshiek Counties and Melanichneumon rubicundus (Say) from 1949 spring-collected pupae in Muscatine County. Pupal collections taken in the latter locality in the spring of 1947 and 1948 showed 4 and 7 percent parasitized by M. rubicundus.

Kentucky

Two collections were taken at Louisville, Jefferson County, where Macrocentrus gifuensis colonies were released in 1948 and initial establishment was shown there. Specimens in a sample of borers taken at the Warren County parasite-colonization site, where the collector had found emerged puparia of Lydella stabulans grisescens, and host larvae, were dissected. L. grisescens larvae were found in some of them. This shows that the species has survived in this locality from a 1947 release.

Michigan

Collections of hibernating corn borer larvae were taken in nine Michigan parasite-colonization localities in the fall of 1948, and in the spring of 1949 in seven additional localities. Since 1939, the only collections taken in the State have been in Erie, Monroe County, where they have been obtained annually since 1927.

Eulophus viridulus was recovered in three localities in 1948, including those sampled in Huron and Macomb Counties, and at Erie, Monroe County, where it was released in 1932, first recovered in 1938, and has been found annually, except in 1940, 1942, and 1947. The only other recoveries of this species in the State were made at Columbus, St. Clair County, when it was released there in 1931 and 1932, but where it was not recovered in four later collections.

Horogenes punctorius was released prior to 1938 in each one of the parasite-colonization sites sampled in the fall of 1948 except Augusta, Washtenaw County, which was sampled in the spring of 1949. No collection had been taken after it was released in the Genesee, Huron, Lapeer, Livingston, and Macomb County localities. It was released at Erie, Monroe County, in 1926 and 1928, and recovered annually from 1933 through 1937 but not later; released at Columbus, St. Clair County, in 1928, 1929, 1930, and 1931, and recovered there in 1931, 1932, and 1933 but not in 1934 and 1935; released, but not recovered, at Augusta in 1937. H. punctorius was recovered in Macomb and Washtenaw Counties in 1948.

Lydella stabulans grisescens was taken at East Lansing, Mich., in the spring of 1948. This was the first occurrence of this species in central Michigan. L. grisescens had been released in one or more years from 1927 through 1935 in every one of the localities sampled in the fall of 1948. No collection was ever obtained from the Huron, Lapeer, and Livingston County sites; no recovery was made in Genesee from a collection in the release year; it was recovered in Macomb one year after it was released, but no later collection was taken there; initial establish-

ment but no survival was shown in collections from Oakland, St. Clair, and Washtenaw Counties; but, it has been taken annually since 1931 at Erie, Monroe County, where it has parasitized an average of over 20 percent of the borers in the past eight years. L. grisescens was recovered at Ida, Monroe County, from a spring collection.

Minnesota

Thirty-five collections, taken according to a polar-coordinate system, were obtained from two Minnesota parasite-colonization localities. Horogenes punctorius had survived in LeSueur County where initial establishment was obtained in 1947. Lydella stabulans grisescens was recovered at localities in both Goodhue and LeSueur Counties in 1948, showing survival for 2 and 1 years, respectively. In LeSueur County there had been considerable dispersion and an encouraging increase in parasitization since 1947. Macrocentrus gifuensis showed initial establishment at the LeSueur County locality in 1947, but it was not recovered in 1948. The native Aplomya caesar (Ald.) was reared from the Goodhue County collection.

Missouri

Five collections were taken at the St. Louis County, Missouri parasite-colonization locality, and Lydella stabulans grisescens was reared from 3 of them, showing survival there where it was released and recovered in 1947.

Nebraska

Fifteen collections, 5 from Dodge County and 10 from Lancaster County, were taken in Nebraska. The only exotic species of parasite released here was Eulophus viridulus in 1948. The only parasite reared from the corn borer was Pyraustomyia penitalis from the Dodge County locality.

New Jersey

Collections were obtained in the fall of 1948 from two special parasite-study areas in New Jersey where collections in an identical area have been taken annually since 1939 on hibernating borers. Collections were taken also on the first generation since 1944 in Burlington, and since 1942 in Monmouth County. Three exotic species of parasites are established in both localities. At the Burlington locality Horogenes punctorius survived through the fall of 1945, and since then parasitization among summer and fall borers has increased annually, attaining its highest percentage in the summer of 1948, when it surpassed Lydella stabulans grisescens. L. grisescens has been the dominant species here in every collection except in the summer of 1948. The highest percentage in any collection was 38 percent in the fall of 1946. Macrocentrus gifuensis has shown a slow rate of increase in percentage of borers parasitized, exceeding 1 percent only in the 1947 and 1948 fall collections, and it is not present throughout the study area. Apparently equilibrium between the species has not been reached.

In the Monmouth County area the three exotic species appear to have reached equilibrium. An average of less than 3.5 percent of the hibernating borers have been parasitized by Horogenes punctorius during the past 7 years, while about 11 percent of the first generation were found parasitized. Lydella stabulans grisescens parasitized about 6 percent of the first generation, and over 12 percent of the hibernating borers during the past 7 years. Macrocentrus gifuensis parasitized a higher percentage of first-generation than hibernating borers through 1944, but after that year the lowest fall percentage was greater than the highest percentage in any summer.

New York

Eighteen collections were obtained from nine parasite-colonization localities in New York and exotic species of parasites were recovered at two localities. Eulophus viridulus has not been released in any one of the seven localities where no recoveries were made, Horogenes punctorius has been released in two, Lydella stabulans grisescens in five, and Macrocentrus gifuensis in every one of the nine localities sampled in 1948. All three species, recovered in the two western New York localities, have been released in the Cattaraugus Indian Reservation, but only L. grisescens was ever released at Eden, Erie County. E. viridulus, H. punctorius, and L. grisescens parasitized about the same percentage of borers in 1947 and 1948 in the Cattaraugus Indian Reservation, but this is the first recovery for each species at Eden.

Ohio

Fifty-three collections from 16 localities in seven Ohio counties were taken in the fall of 1948 and spring of 1949, and they contained 2,133 specimens. Chelonus annulipes Wesm., was recovered from hibernating corn borer larvae at Adams, Lucas County, where it was last taken in 1945. Eulophus viridulus was taken in Erie and Lucas Counties, where it has persisted at a low level since 1938. Horogenes punctorius has persisted and shown some dispersion from the Van Wert County colonization site since it was released there in 1946. Recovery of H. punctorius in three other Ohio Counties (Fulton, Lucas, and Wood) in the spring of 1949 shows that it has persisted there for several years, since no release has been made in northwestern Ohio, except at Van Wert, since 1937. Lydella stabulans grisescens has persisted near the shore of Lake Erie, in the Perkins, Erie County, and Jerusalem, Lucas County, localities for 20 years, where it has parasitized an average of more than 15 percent of the borers in the past 5 years. In 1948, however, the percentage in both localities was below the average. It has persisted at Ridge, Van Wert County, since its establishment in 1945. The 1948 recovery in the Franklin County locality is the first since it was released in 1947. Macrocentrus gifuensis showed initial establishment at Ridge, Van Wert County, in 1947 but it was not recovered in 1948.

Wisconsin

Ten collections were obtained from eight parasite-colonization localities in Wisconsin, including 7 localities where one or more exotic species had been recovered previous to 1948, and one, St. Croix County, first colonized this year. Three exotic species were recovered. Horogenes punctorius had shown initial establishment in Dane and Jefferson Counties in 1946, and in La Crosse and Rock Counties in 1947. In 1948 it was not recovered in Dane and Rock, but it had survived in Jefferson and La Crosse Counties. Lydella stabulans grisescens was released and recovered in Fond du Lac and Sauk Counties in 1947, but the 1948 records showed no survival. This species is apparently well established in 4 counties as shown by its survival for 1 year in Dane and La Crosse after the last release was made, and 4 years in Jefferson and Rock Counties. Prior to 1948, Macrocentrus gifuensis had shown initial establishment in seven counties, but no survival was shown when collections were taken in a later year. Survival was evident in La Crosse County in 1948 where it was released and recovered in 1947. The native Aplomya caesar was taken in Sauk County.

Results of Extensive Surveys

A survey was conducted in the fall of 1948 in 12 Eastern and 4 Middle Western States, in cooperation with State entomologists, to determine the dispersion and abundance of European corn borer parasites. The rectangular coordinate design used in the Eastern States in a similar survey in 1947 was used in all Eastern States surveyed this year, and in central Kentucky in the Middle Western States, but all other Middle Western areas were sampled by selecting townships which provided a restricted random design. The areas where collections were taken are shown in figure 1. The estimated total area surveyed was 55,900 square miles (about the size of Illinois, Iowa, or Wisconsin) including 42,600 square miles (about the size of Ohio or Virginia) in the Eastern States, and 13,300 square miles (about the size of Maryland) in the Middle Western States.

Eastern States Areas

The 1948 data for the area comprised by the 25 Eastern States, involving 461 collections and 21,143 borers, are summarized in table 2, and comparable data for this and previous years are shown in table 3.

Maine

Area 1. No estimate was made for this area because the seven samples taken were widely scattered. The only exotic species of parasite ever colonized in the State was Lydella stabulans grisescens at Wells, York County. Horogenes punctorius and Macrocentrus gifuensis were recovered in South Berwick, York County, and the native Aplomya caesar was taken in Yarmouth, Cumberland County, in the 1948 collections.

New Hampshire

Area 2. No exotic European corn borer parasites have been released in this area and none was recovered in 1948. Aplomya caesar was taken in four sections in the area in 1948.

Area 3. Horogenes punctorius was released in one locality in this area in 1937, and was recovered there in 1941; Lydella stabulans grisescens was released in three localities in 1935, and recovered from one locality in 1941, the only year in which a collection was made in the State. Of the 25 collections in 1948, H. punctorius was recovered from five, L. grisescens from one, and Macrocentrus gifuensis from eight localities. H. punctorius and M. gifuensis were recovered in sections near the boundary of Massachusetts where these two species are prevalent. The natives Aplomya caesar and Meteorus loxostege Vier. were taken in one section.

Massachusetts

Area 4. Chelonus annulipes was recovered in 1948 from one section contiguous to area 6 where this species is taken annually. The percentage of borers attacked by Horogenes punctorius has declined annually but occurrence of the parasite among samples has been quite constant. Lydella stabulans grisescens has remained at a low level, having been taken in less than 30 percent of the samples in any one of the past 4 years. Macrocentrus gifuensis is the dominant species here, as shown by the percentage of borers parasitized in each of the past 4 years. In each of the last 3 years it was taken in every one of the collections.

Area 5. Horogenes punctorius was the dominant species in this area in 1945 and 1946, and in the 4 years, 1945-48, the percentage of collections from which it has been taken was constant. Lydella stabulans grisescens has been taken only in the Connecticut River Valley in the western part of the area in 1947 and 1948, but it was found more widespread in the two preceding years. The percentage of borers parasitized by Macrocentrus gifuensis has increased annually. It was taken in 29, 41, 52, and 90 percent of the sections in 1945, 1946, 1947, and 1948, respectively.

Rhode Island and Southeastern Massachusetts

Area 6. Chelonus annulipes was taken in 7, 10, 10, and 20 percent of the collections in this area in 1945, 1946, 1947, and 1948, and the percentage of borers parasitized by it was greatest in the last year. Horogenes punctorius has been taken only in the northwestern and southwestern parts of this area in the last 4 years, and Lydella stabulans grisescens has been taken in less than 10 percent of the collections in any year. Macrocentrus gifuensis, the dominant species here, has appeared in more than 95 percent of the collections during the 4 years.

Connecticut

Area 7. Chelonus annulipes was recovered in only one collection in this area in each of the three years, 1945, 1946, and 1947, but in 1948 it was taken in three collections. Horogenes punctorius parasitized a smaller percentage of borers in 1947 and 1948 than in 1945 and 1946. It was recovered from 66 percent of the collections in 1945 and 1946, but from only 23 and 35 percent in 1947 and 1948, respectively. Lydella stabulans grisescens was taken from collections scattered throughout the area in the 4 years. Macrocentrus gifuensis has shown an annual increase in the percentage of borers parasitized, and it was taken in 77, 94, 94, and 100 percent of the collections in 1945, 1946, 1947, and 1948, respectively.

New York

Area 8. Chelonus annulipes, Lydella stabulans grisescens, and Macrocentrus gifuensis, the three exotic species recovered here in 1947 and 1948, each parasitized a higher percentage of borers in the last year. The percentage of borers parasitized in the 10-mile-square section which produced C. annulipes was 7 and 11 in 1947 and 1948, respectively; L. grisescens, 36 and 75; and M. gifuensis, 79 and 86. Each species was more abundant and more generally present in the area in 1948 than in 1947.

New Jersey

Collections were taken throughout the State in 1947 and 1948.

Area 9. Horogenes punctorius parasitized a lower percentage of borers in 1948, when it was taken in only one collection, than in 1947, when it occurred in two collections. Lydella stabulans grisescens, in 1948, parasitized more than twice the percentage of borers in 1947. L. grisescens was recovered in all but one collection in 1947 and it was taken in every collection in 1948. The number of collections in which Macrocentrus gifuensis was taken increased from 45 to 65 percent from 1947 to 1948, and the percentage of borers parasitized was more than doubled.

Area 10. Chelonus annulipes was recovered from one section in Middlesex County in 1948. This species was last recovered in the State in Monroe, Middlesex County, in 1945. Horogenes punctorius parasitized a lower percentage of borers in 1948 than in 1947, but it was taken in 6 collections in 1947 and 7 in 1948. Lydella stabulans grisescens was taken in every one of the collections in 1947 and 1948, and the percentage of borers which it parasitized was nearly twice as high in 1948 as in 1947. Macrocentrus gifuensis showed nearly three times the percentage of borers parasitized in 1948 as in 1947. It was taken in 6 collections in 1947 and 14 in 1948.

Area 11. Horogenes punctorius, Lydella grisescens, and Macrocentrus gifuensis each parasitized a higher percentage of borers here in 1948 than in 1947. Also, the percentage of collections in which they were taken in the 2 years increased from 24 to 44 for H. punctorius; from 94 to 100 for L. grisescens; and from 18 to 50 for M. gifuensis.

Area 12. Lydella stabulans grisescens was the only species of parasite recovered in this area in 1947 when it was taken in 91 percent of the collections. In 1948, it was taken in every one of the collections, and Horogenes punctorius and Macrocentrus gifuensis were recovered from 25 and 17 percent of the collections, respectively.

Pennsylvania

Area 13. Lydella stabulans grisescens was recovered from every one of the collections in this area in 1947 and 1948, but the percentage of parasitization was twice as high in 1948 as in 1947. Macrocentrus gifuensis was taken in one of four collections in 1947, and in one of six in 1948.

Area 14. Lydella stabulans grisescens was taken in every one of the collections in 1947 and 1948. The percentage of borers attacked in 1948 was more than twice that in 1947. Macrocentrus gifuensis was taken in only one of six 1947 collections, but it was recovered from four of ten. taken in 1948.

Area 15. Lydella stabulans grisescens showed a higher percentage of borers attacked here in 1948, when it was taken in every one of 8 collections, than in 1947 when it occurred in 11 of 12 collections from the area. Macrocentrus gifuensis, which was not recovered here in 1947, was taken in two 1948 collections.

Area 16. Lydella stabulans grisescens was recovered from the 10 easternmost, but not in the 8 western, collections in this area in 1947, but in 1948 it was recovered from every one of the 16 collections taken. Macrocentrus gifuensis was recovered in one collection in 1947 but none was found in 1948.

Delaware

Area 17. Parasitization by Lydella stabulans grisescens was more than twice as high in the State in 1948 as in 1947, and the parasite was recovered in all but 1 of the 30 collections taken each year. Macrocentrus gifuensis was taken in 1 of the northernmost collections each year.

Maryland

Area 18. Lydella stabulans grisescens was recovered from 67 and 91 percent of the sections sampled in this area in 1947 and 1948, respectively. In the latter year it failed to appear in only three of the most northwestern sections, when the percentage of hosts parasitized was more than that found in 1947. Macrocentrus gifuensis was taken only in one western and one northeastern collection in 1947. In 1948 it was recovered in two collections in the northeastern part of the area and in eight collections in the central and southern parts.

Area 19. Lydella stabulans grisescens was the only species of parasite recovered in this area in the years 1947 and 1948, and the percentage of borers attacked was higher in 1948 than in 1947.

Area 20. Horogenes punctorius was taken in the most southern of 7 sections sampled in 1947, but it was not recovered in 1948. Lydella stabulans grisescens was reared from 6 of the 7 collections taken in 1947, and from every one taken in 1948, when the percentage of borers parasitized by it was twice that found in the previous year.

Area 21. Lydella stabulans grisescens, the only exotic species of parasite recovered here in 1947 and 1948, parasitized only 7 percent of the borers, and was taken in only four of the six collections from the area in 1947. In 1948, it was taken in each of the four collections obtained, and parasitized 35 percent of the borers.

Virginia

Area 22. Previous to 1948 no collection had been taken to determine the status of parasites in northern Virginia where Horogenes punctorius, Lydella stabulans grisescens, and Macrocentrus gifuensis were released in 1944 and 1945. Lydella stabulans grisescens was recovered from every one of the six collections taken here in 1948, and it had parasitized 41 percent of the 289 hosts observed. Macrocentrus gifuensis was taken in one collection. This is the first record of recovery of this species in the State.

Area 23. Lydella stabulans grisescens is the only species reared from the borer in this area in 1947 and 1948. The percentage of hosts parasitized was a little lower here in 1948 than in 1947. In each year, it was taken in every one of the collections except the most northwestern one.

Area 24. Lydella stabulans grisescens parasitized a little higher percentage of borers here in 1948 than in 1947. In 1947 it was taken in every one of the 9 collections obtained, while in 1948 it was not taken in 2 of the 17 collections.

North Carolina

Area 25. Lydella stabulans grisescens is the only exotic species ever recovered in the area. In the portion surveyed the percentage of borers parasitized by it was a little higher in 1948 than in 1947. It was recovered in 4 of the 6 collections taken in 1947, and in 13 of the 15 taken in 1948.

Middle Western States Areas

The 1948 data for the 10 Middle Western States areas, involving 140 collections and 6,142 borers, are summarized in table 4. Most of these areas were surveyed this year because previous records taken in the vicinity of parasite-colonization sites had shown that Lydella stabulans grisescens had become abundant in them and considerable dispersion was indicated as having occurred. This species was the only exotic one taken in Areas 26, 27, and 28, in Kentucky, Ohio, and Illinois, respectively.

Kentucky

Area 26. Lydella stabulans grisescens accounted for 14 percent of the borers observed, and was taken in 15 of the 22, 10-mile-square sections sampled. Pyraustomyia penitalis was the only native species recovered here.

Ohio

Area 27. Lydella stabulans grisescens parasitized 21 percent of the borers in this area, where 12 samples were taken in 10 townships. Pyraustomyia penitalis was reared from the borers in two collections, and parasitized 12 percent in one collection.

Illinois

Area 28. About every other township in seven counties in this area were sampled. Lydella stabulans grisescens had parasitized 30 percent of the borers, and it was taken in 28 of the 29 collections.

Iowa

Two native larvaevorid species were taken in the Iowa areas. Aplomya caesar was taken in area 29 (northeastern) and Pyraustomyia penitalis was taken in every area except 32 (Benton County).

Area 29. Twenty-one townships, including most of four counties, were sampled in this area. Eulophus viridulus was taken in three, Horogenes punctorius in one, Lydella stabulans grisescens in nine, and Macrocentrus gifuensis in one, of the townships. The three species were more abundant, or were taken only in the southern part of the area. This is the only one of the Middle Western States areas surveyed in which M. gifuensis was recovered. Two native larvaevorid species were reared from the borers in this area, the only Middle Western area in which Aplomya caesar was taken.

Area 30. Nineteen townships in three counties were sampled. Eulophus viridulus was taken in five, Horogenes punctorius in one, and Lydella stabulans grisescens in every one of them. Thirty-eight percent of the borers were parasitized by L. grisescens, the highest parasitization found in any Middle Western area surveyed.

Area 31. Thirteen townships in three counties were sampled in area 31. Eulophus viridulus was taken in four, and Lydella stabulans grisescens in every one, of the samples.

Area 32. Only four samples, all from Benton County, were taken in this area. Eulophus viridulus was taken in one, Horogenes punctorius in two, and Lydella stabulans grisescens in all four, of the samples. The percentage of parasitization in the two samples where H. punctorius was taken was 6 and 12. The H. punctorius records here are of special interest because the only other areas where 12 or a higher percentage was recorded were in the Eastern States, including 1 sample in area 4, 6 in area 5, and 1 each in areas 10 and 11.

Area 33. Lydella stabulans grisescens was recovered from one of six samples taken in this area.

Area 34. Lydella stabulans grisescens was recovered from one of the three samples taken.

Area 35. No exotic species were recovered from two samples taken in the area.

A Resumé of the Status of Exotic Species of Parasites

Chelonus annulipes

At the close of 1948 there was some evidence that Chelonus annulipes is spreading over larger areas in central Connecticut, southeastern Massachusetts, and Rhode Island where it has been present for several years but only in very limited areas. It has persisted for 8 years in a limited area in the Hudson River Valley in New York. Recoveries in north-central New Jersey and northwestern Ohio show that it has survived in one locality in each of these States.

Eulophus viridulus

The 1948 recoveries of Eulophus viridulus were from five States and showed the following: Considerable dispersion in the State of Indiana; wide dispersion in eastern and east-central Iowa, and establishment in the northwestern part of the State; recoveries in 3 localities in Michigan, and two localities in Ohio, all of which were near the shores of the Great Lakes; dispersion into one western New York locality and persistence in another, both near Lake Erie, and the most eastern localities in which E. viridulus has been recovered.

Horogenes punctorius

Horogenes punctorius was found generally present in an area extending from southern Maine, through southeastern New Hampshire, and in southern New England, except in southeastern Massachusetts. It had persisted in northern New Jersey, and was taken in widespread collections in central and southern New Jersey. It has persisted for several years in one locality in western New York, and in 1948, had spread to a second. H. punctorius was recovered from hibernating borers this year in northeastern Indiana, where it had not been known to occur for 10 years; in southeastern Michigan; and in northwestern Ohio, where it has survived for 3 years in one locality. Recoveries in eastern and east-central Iowa, southern and western Wisconsin, and in south-central Minnesota showed survival of the species, and indicate that permanent establishment has been accomplished in these localities.

Lydella stabulans grisescens

Lydella stabulans grisescens is the most widely established and abundant of the exotic species, except in the New England States and New York, where it occurred frequently among the collections but, in most of them, parasitized only a low percentage of borers. The areas and localities are shown in figure 2. It was found throughout New Jersey and Delaware; in extensive areas in Pennsylvania; in most of Maryland; in areas surveyed in northern and southeastern Virginia, and throughout the Eastern Shore of this State; and in northeastern North Carolina. Wherever surveys were made it was taken in nearly all of the collections, and was generally abundant having parasitized from 16 to 45 percent of the borers observed in these areas. L. grisescens was found widely distributed, but not present throughout the area surveyed in central Kentucky; throughout the extensive areas surveyed in Ohio; Illinois; and the east-central and southeastern areas in Iowa. It has persisted in many localities; shown some dispersion in central and northwestern Ohio, Michigan, Indiana, Illinois, Missouri, eastern and central Iowa, Wisconsin, and Minnesota; and initial establishment in one northwestern and one southwestern, Iowa locality.

Macrocentrus gifuensis

Macrocentrus gifuensis was found in southern Maine, and in southeastern New Hampshire adjoining the Massachusetts area in which it was most abundant in 1948 (37 percent). It is the dominant species throughout that State, Connecticut, Rhode Island, and the Hudson River Valley in New York. M. gifuensis was found widely distributed throughout New Jersey and it was recovered and showed survival in Delaware, Pennsylvania, and in northern Maryland and northern Virginia. In the Middle Western States it showed survival for more than 1 year in northeastern and north-central Iowa, and in western Wisconsin; initial establishment in Indiana, Kentucky, and eastern Iowa, and survival until spring in one of them; but there is no evidence that it has become permanently established in this region.

Table 1.--Numbers of hibernating European corn borers observed, and parasitization in the fall, winter and spring, 1948-49 from localities in most of which one or more exotic species of parasites have been colonized¹.

Locality (State-County-Township)	Number of borers observed	Percentage of borers parasitized by:							Total parasitization (Percent)
		Chelonus annulipes	Eulophus viridulus	Horoglyphus punctatorius	Lydella stabulans griseus	Macrocentrus gifuensis	Native parasites		
Illinois:									
Champaign, Harwood	62	-	-	-	-	-		0	
Hancock, Prairie	449	-	-	-	1	0	22/	3	
Kankakee, St. Anne	32	0	-	0	25	0		25	
La Salle, Bruce	271	-	-	0	17	0		17	
Logan, West Lincoln	10	-	0	0	10	0		10	
Peoria, Timber	34	-	-	-	0	0		0	
Rock Island, Black Hawk	141	0	0	0	18	0		18	
Vermilion, Grant	43	-	-	0	14	0		14	
Woodford, Roanoke	43	-	-	-	33	0		33	
Indiana									
Blackford, Washington	183	-	-	-	15	0		15	
Clay, Harrison	36	-	-	0	28	0		28	
Fayette, Harrison	158	-	-	0	-	0		0	
Hamilton, Noblesville	19	-	-	-	16	0		16	
Hendricks, Union	92	-	-	-	1	0		1	
Henry, Franklin	107	-	-	-	5	0		5	
Jasper, Union	399	-	8	0	12	0		20	
Kosciusko, Clay	120	-	6	-	2	0	.82/	.8	
La Porte, Johnson	85	-	-	-	-	0	1 12/	1	
Marshall, Center	88	-	-	0	0	0		0	
Porter, Boone	234	-	-	-	7	0		7	
Putnam, Russell	103	-	-	-	13	0		13	
St. Joseph, Warren	86	-	-	-	12	0		12	
Steuben, York (Clear Lake)	195	0	0	10	4	.5	.52/	15	
Switzerland, Jefferson	111	-	0	-	25	0		25	
Tippecanoe, Jackson	63	0	-	-	21	0		21	
Tipton, Wildcat	569	0	-	0	27	0		27	
Vermillion, Newport	31	-	3	-	3	0		6	
Iowa									
Boone, Des Moines	57	-	-	-	-	0		0	
Dickinson, Okoboji	48	-	-	-	-	0		0	
Fremont, Green	152	-	-	-	1	0		1	
Greene, Jackson	53	-	-	-	-	0		0	
Hancock, Britt	65	-	-	-	-	3		3	
Harrison, Harrison	175	0	0	0	0	0		0	
Humboldt, Grove	46	-	-	-	-	0		0	

Table 1.--Continued

Locality (State-County-Township)	Number of borers observed	Percentage of borers parasitized by:						Total parasitization (Percent)
		<u>Chelonus</u> <u>annulipes</u>	<u>Eulophus</u> <u>viridulus</u>	<u>Horogenes</u> <u>punctatorius</u>	<u>Lydella</u> <u>stabulans</u> <u>griseus</u>	<u>Macrocentrus</u> <u>gifuensis</u>	<u>Native</u> <u>parasites</u>	
Iowa: (Continued)								
Jackson, Monmouth	44	-	2	0	32	0		34
Kossuth, Wesley	56	-	-	-	-	0		0
Linn, Marion	250	0	0	-	11	-	.42/	12
Lyon, Rock	36	-	-	-	-	0		0
Marshall, Liscomb	159	0	-	0	20	0		20
Mills, Center	48	-	-	-	-	0		0
Muscatine, Lake	567	-	-	0	23	0		23
Sweetland	550	0	0	0	28	1		29
"	422 3/4	0	0	0	13	1	3/	14
Osceola, East Holman	42	-	-	-	-	0		0
Plymouth, Elgin	105	-	1	-	5	-		6
Poweshiek, Sheridan	216	-	1	-	.5	0	.52/	2
Webster, Lost Grove	30	-	-	-	3	0		3
Wright, Lincoln	52	-	-	-	-	0		0
Kentucky:								
Jefferson, Louisville	142	-	-	-	-	.7		.7
Michigan:								
Genesee, Genesee	49	-	-	0	6	-		6
Huron, Sebawaing	53	-	2	0	24	-		26
Lapeer, Goodland	49 1/4	-	-	0	2	-		2
Lenawee, Deerfield	18 1/4	-	-	-	-	-		0
Ridgeway	41 1/4	-	-	-	-	-		0
Riga	36	-	-	0	11	-		11
Livingston, Conway	48	-	2	2	15	-		19
Macomb, Harrison	272 1/4	0	1	0	17	0		18
Monroe, Erie	20 1/4	-	-	-	5	-		5
Ida	45 1/4	-	-	-	-	-		0
Whiteford	51	-	0	-	2	0		2
Oakland, Oxford	43 1/4	-	-	0	12	0		12
St. Clair, Columbus	21 1/4	0	0	0	-	0		0
Washtenaw, Augusta	49 1/4	-	-	4	27	-		31
Northfield	21 1/4	-	-	-	-	-		0
Saline								
Minnesota:								
Goodhue, Pine Island	654	-	-	0	2	0	.54/	2
Le Sueur, Tyrone	450	-	0	1	11	0		13

Table 1.--Continued

Locality (State-County-Township)	Number of borers observed	Percentage of borers parasitized by:						Total parasitization (Percent)
		<u>Chelonus</u> <u>annulipes</u>	<u>Eulophus</u> <u>viridulus</u>	<u>Horogenes</u> <u>punctatorius</u>	<u>Lydella</u> <u>stabulans</u> <u>griseus</u>	<u>Macrocentrus</u> <u>gifuensis</u>	Native parasites	
Missouri:								
St. Louis, Meramec	87	-	-	0	7	0		7
Nebraska:								
Dodge, Platte	199	-	0	-	-	-	22/	2
Lancaster, Stevens Creek	424	-	0	-	-	-		0
New Jersey:								
Burlington, Burlington	818	0	0	6	18	2	.16/	26
Monmouth, Atlantic	781	0	0	4	23	12	.17/	39
New York:								
Cattaraugus Indian Reservation	413	-	4	12	1	0	.75/	18
Erie, Eden	47	-	2	2	2	0		6
Lancaster	47	-	-	0	0	0		0
Monroe, Gates	50	-	-	-	-	0		0
Irondequoit	35	-	-	-	-	0		0
Niagara, Cambria	50	-	-	-	0	0		0
Oneida, Marcy	38	-	-	-	0	0		0
Onondaga, Salina	53	-	-	-	0	0		0
Ontario, Phelps	52	-	-	0	0	0		0
Ohio:								
Clark, Bethel	361	-	-	-	0	0		0
Erie, Perkins	370	0	1	0	12	0		13
Franklin, Clinton	92 4/	-	-	-	1	0		1
Fulton, German	16 4/	0	-	0	0	-		0
Gorham	23 4/	-	-	13	-	-		13
Royalton	29 4/	-	-	7	-	-		7
York	13	-	-	-	-	-		0
Lucas, Adams	71 4/	18/	-	1	1	0		3
Jerusalem	539	0	.2	0	10	0		11
Maumee	44 4/	-	-	-	-	-		0
Richfield	32 4/	-	-	6	-	-		6
Van Wert, Ridge	491 4/	-	-	3	6	0		9
Wood, Center	6 4/	-	-	-	-	-		0
Liberty	25 4/	-	-	4	-	-		4
Perrysburg	35 4/	-	-	-	-	-		0
Webster	26 4/	-	0	-	0	0		0

Table 1.--Continued

Locality (State-County-Township)	Number of borers observed	Percentage of borers parasitized by:						Total parasitization (Percent)
		<u>Chelonus</u> <u>annulipes</u>	<u>Eulophus</u> <u>viridulus</u>	<u>Horogenes</u> <u>punctorius</u>	<u>Lydella</u> <u>stabulans</u> <u>griseus</u>	<u>Macrocentrus</u> <u>gifuensis</u>	<u>Native</u> <u>parasites</u>	
Wisconsin:								
Buffalo, Alma	14	-	-	-	-	0		0
Dane, Fitchburg	154	-	0	0	13	0		13
Fond du Lac, Springvale	132	-	-	0	0	0		0
Jefferson, Waterloo	149	0	-	2	7	0		9
La Crosse, Hamilton	136	-	0	2	6	2		9
Rock, Beloit	130	-	-	0	15	0		15
Sauk, Excelsior	50	-	-	-	0	0	25/	2
St. Croix, Kinnickinnic	58	-	0	-	0	-		0

1/ 0 indicates that this species has been released, but was not recovered this year. A dash (-) indicates no release or recovery.

2/ Pyraustomyia penitalis Coq.

3/ Collected in the spring of 1949, including 129 pupae of which 3 percent were parasitized by the native ichneumon Melanichneumon rubicundus.

4/ Collected in the spring of 1949.

5/ Apomyia caesar Ald.

6/ Cremastus sp.

7/ Bassus agilis Cress.

8/ Chelonus annulipes and Horogenes punctorius were also recovered in small numbers from several thousand larvae used in other investigations.

Table 2.--European corn borer larvae observed, and parasitization in collections made in the fall of 1948 in the Eastern United States to determine the distribution and abundance of parasites

Area located in	Area number	Approximate size sq. mi.	Number of collections	Number of borers observed	Percentage of borers parasitized by:				
					Chelonus annulipes	Horogenes punctatorius	Lydella stabulans griseascens	Macrocentrus giffuensis	Native parasitic sites
Maine	1	1/	7	298	-	0.7	-	0.3	0.3 ^{2/}
New Hampshire:									
Central	2	1,400	15	632	-	-	-	-	-
Southeastern	3	2,400	25	1,163	-	1	T ^{3/}	1	.6 ^{2/} .4 ^{4/}
Massachusetts:									
Eastern	4	2,400	24	1,242	.2	2	.8	37	T ^{2/}
Central	5	3,000	31	1,545	-	7	.3	16	.3 ^{2/}
Rhode Island and									
Southeastern	6	3,000	30	1,630	1	.2	.6	26	T ^{2/}
Massachusetts	7	3,500	34	1,589	.9	1	.6	36	T ^{2/}
Connecticut									
New York:									
Hudson River Valley	8	3,300	34	1,463	.9	-	5	24	.1 ^{5/}
New Jersey:									
Northern	9	2,700	31	1,507	-	T	26	11	T ^{6/}
North Central	10	1,400	16	758	.1	1	39	8	.1 ^{2/}
South Central	11	1,500	18	843	-	4	25	4	-
Southern	12	1,900	24	1,191	-	2	21	.6	.2 ^{6/}
Pennsylvania:									
East Central	13	600	6 ^{7/}	115	-	-	41	.9	-
Near Philadelphia	14	500	10 ^{7/}	308	-	-	34	3	.3 ^{8/}
Southeastern									
East of Susquehanna	15	800	8	355	-	-	26	1	-
River									
West of Susquehanna	16	1,400	12	574	-	-	16	-	.5 ^{6/}
River									

Table 2.—Continued

Area located in	Area number	Approximate size sq. mi.	Number of collections	Number of borers observed	Percentage of borers parasitized by:					All species
					<u>Chelonus annulipes</u>	<u>Horogones punctatorius</u>	<u>Lydella stabulans</u>	<u>Macrocentrus gifuensis</u>	<u>Native parasitic sites</u>	
Delaware	17	2,400	30	1,298	-	-	30	0.3	0.2 ^{6/}	30
Maryland:										
Northern	18	3,400	36	1,601	-	-	28	2	.1 ^{6/}	30
Southern	19	500	5	170	-	-	40	-	-	40
Eastern Shore										
Northern	20	900	11	508	-	-	45	-	-	45
Southern	21	500	4	162	-	-	35	-	-	35
Virginia:										
Northern	22	600	6	289	-	-	41	.3	.3 ^{6/}	42
Eastern Shore	23	700	12	610	-	-	17	-	-	17
Southeastern	24	1,800	17	629	-	-	18	-	2 ^{2/}	20
North Carolina	25	2,000	15	663	-	-	19	-	.9 ^{6/}	20
Total		42,600	461	21,143						

1/ Area not estimated since the samples were widely separated.

2/ Aplomya caesar Ald.

3/ T indicates less than .1 percent.

4/ Aplomya caesar and Meteorus loxostege.

5/ Bassus agilis Cress.

6/ Pyraustomyia penitalis.

7/ Six collections, made as part of the Burlington, N.J. special study point observations, are included here.

8/ Cromastus sp.

9/ Aplomya caesar and Pyraustomyia penitalis.

Table 3.--The status of European corn borer parasites in areas in Eastern States where comparable data were obtained in the fall of 1945, 1946, 1947, and 1948

Area and year	Number of borers observed	Percentage of borers parasitized by:					
		<u>Chelonus</u> <u>annulipes</u>	<u>Horogenes</u> <u>punctorius</u>	<u>Lydella</u> <u>stabulans</u> <u>grisescens</u>	<u>Macro-</u> <u>centrus</u> <u>gifuensis</u>	Native species	All species
Area 4:							
1945	1,252	0.0	6	0.6	24	0.1 ¹ / ₂	31
1946	1,297	0	5	.5	23	.8 ² / ₂	29
1947	1,176	0	3	.3	22	0	25
1948	1,242	.2	2	.8	37	T 3 ¹ / ₂	40
Area 5:							
1945	1,419	0	11	1	4	0	16
1946	1,429	0	14	.6	5	1 2 ¹ / ₂	20
1947	1,431	0	6	.2	6	0	12
1948	1,545	0	7	.3	16	.3 ² / ₂	24
Area 6:							
1945	1,598	.4	.3	.6	28	0	29
1946	1,485	.9	.2	1	36	.4 ² / ₄	39
1947	1,349	.3	.1	.7	20	.1 ¹ / ₂	21
1948	1,630	1	.2	.6	26	T 3 ¹ / ₂	28
Area 7:							
1945	1,854	.2	5	.5	18	0	24
1946	1,871	.1	5	.7	22	.9 ² / ₄	28
1947	1,790	.1	1	.2	24	.1 ¹ / ₂	25
1948	1,589	.9	1	.6	36	T 3 ¹ / ₂	38
Area 8:							
1947	640	.2	0	2	16	0	18
1948	1,463	.9	0	5	24	.1 ⁴ / ₂	30
Area 9:							
1947	1,402	0	.1	12	4	.3 ⁵ / ₆	16
1948	1,507	0	T	26	11	T 6 ¹ / ₂	37
Area 10:							
1947	729	0	2	20	3	0	24
1948	758	.1	1	39	8	.1 ² / ₂	49
Area 11:							
1947	733	0	.7	16	2	.1 ⁶ / ₂	18
1948	843	0	4	25	4	0	32
Area 12:							
1947	886	0	0	15	0	0	15
1948	1,191	0	2	21	.6	.2 ⁶ / ₂	23
Area 13:							
1947	128	0	0	19	2	0	21
1948	115	0	0	41	.9	0	42
Area 14:							
1947	320	0	0	13	4	.3 ⁶ / ₂	18
1948	308	0	0	34	3	.3 ⁷ / ₂	38

Table 3.--Continued

Area and year	Number of borers observed	Percentage of borers parasitized by:					
		<u>Chelonus annulipes</u>	<u>Horogenes punctorius</u>	<u>Lydella stabulans</u> <u>grisescens</u>	<u>Macrocentrus gifuensis</u>	Native species	All species
Area 15:							
1947	537	0	0	20	0	0	20
1948	355	0	0	26	1	0	27
Area 16:							
1947	862	0	0	9	.1	0 ^{6/}	9
1948	574	0	0	16	0	.5 ^{6/}	17
Area 17:							
1947	1,381	0	0	12	.1	0 ^{6/}	12
1948	1,298	0	0	30	.3	.2 ^{6/}	30
Area 18:							
1947	714	0	0	13	1	0 ^{6/}	14
1948	1,601	0	0	28	2	.1 ^{6/}	30
Area 19:							
1947	88	0	0	27	0	0	27
1948	170	0	0	40	0	0	40
Area 20:							
1947	247	0	.4	22	0	0	23
1948	508	0	0	45	0	0	45
Area 21:							
1947	230	0	0	7	0	.4 ^{6/}	7
1948	162	0	0	35	0	0	35
Area 23:							
1947	571	0	0	20	0	0	20
1948	610	0	0	17	0	0	17
Area 24:							
1947	384	0	0	13	0	.5 ^{6/}	13
1948	629	0	0	18	0	2 ^{8/}	20
Area 25:							
1947	256	0	0	14	0	0 ^{6/}	14
1948	663	0	0	19	0	.9 ^{6/}	20

- 1/ Macrocentrus robustus Mues.
- 2/ Aplomya caesar Ald.
- 3/ Aplomya caesar, T equals less than .1 percent.
- 4/ Bassus agilis Cress.
- 5/ Bassus agilis and Pyraustomyia penitalis.
- 6/ Pyraustomyia penitalis.
- 7/ Cremastus sp.
- 8/ Aplomya caesar and Pyraustomyia penitalis.

Table 4.—European corn borer larvae observed, and parasitization in collections made in the fall of 1948 in the midwestern United States to determine the distribution and abundance of parasites

Area located in	Area number	Approximate size sq. mi.	Number of collections	Number of borers observed	Percentage of borers parasitized by:				All species
					Eulophus viridulus	Horogenes punctorius	Lydella stabulans	Native species	
Kentucky	26	2,500	28	1,302	—	—	14	0.5 $\frac{1}{1}$	14
Ohio	27	1,000	12	556	—	—	21	1.2 $\frac{1}{1}$	22
Illinois	28	4,300	29	611	—	—	30		30
Iowa:									
Northeastern	29	2,000	24	1,202	.3	.2	5	.4 $\frac{2}{1}$	6 $\frac{3}{1}$
East Central	30	1,800	19	1,001	.6	.2	38	.8 $\frac{1}{1}$	40
Southeastern Central	31	1,200	13	711	.6	—	20	.1 $\frac{1}{1}$	21
Benton County	32	150	4	247	.8	4	15	.1 $\frac{1}{1}$	21
Mahaska County	33	250	6	266	—	—	3	.9 $\frac{1}{1}$	4
Marshall County	34	100	3	148	—	—	.7	2	3
West Central		4/	2	98	—	—	—	2 $\frac{1}{1}$	2
Harrison	35				—	—	—		
Total		13,300	140	6,142					

1/ *Pyraustomyia penitalis*.

2/ *Apomya caesar* and *Pyraustomyia penitalis*.

3/ *Macrocentrus gifuensis*, amounting to .2 percent, was also recovered here.

4/ Area not estimated since only two samples were taken.

